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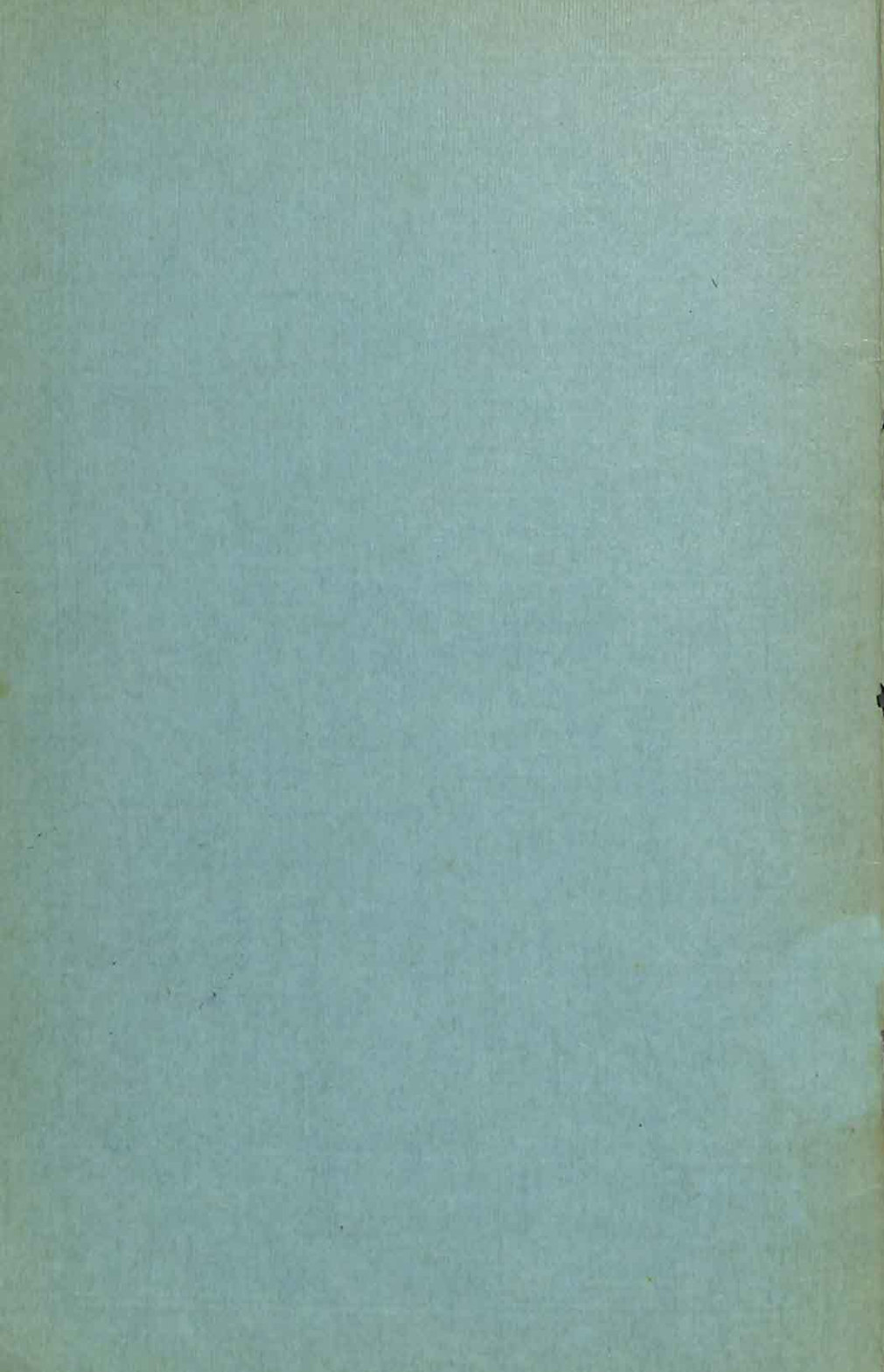
**CURRICULUM
FOR PUPILS OF TWELVE
TO FIFTEEN YEARS
(Advanced Division)**

Reprint No. 12
RURAL SUBJECTS

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PANEL ON RURAL SUBJECTS

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RURAL SUBJECTS

Introductory.—The last quarter-century has witnessed a fairly general acceptance in this country of the principle that primary education gains in vividness and reality by environmental reference. In its application to the education of the rural child the principle involves the introduction into the school curriculum of a rural bias which, it may be emphasised, is something quite distinct from vocational training. Whether the future occupation of the child should influence, in any considerable measure, the character of his education, is arguable. In any case, one is faced with the practical difficulty of uncertainty as to the pursuit which the child may eventually follow—a large proportion of rural children, for example, will be absorbed of necessity into the urban population, and there is the further consideration that education at the primary stage, in the main, must be concerned with fundamentals designed, primarily, to develop the child's personality, to beget in him an appreciation of his position in nature and in life, and to familiarise him with the materials and the tools through which he may arrive at self expression and adequately come to play his part as citizen.

It is needless to suppose that the teaching of Rural Science in the Advanced Division will be successful unless some elementary work is done systematically in the Primary School. To this end the scheme of Nature

Study should be revised when the Rural Science scheme is drawn up, so that there may be a co-ordinated system of instruction throughout the school. The teaching of Rural Science should be regarded as amplifying the existing knowledge of environment, that knowledge which has been systematically obtained by direct study of nature throughout the school years.

The rôle of rural bias in the educational scheme is perhaps sufficiently well expressed by the English Board of Education. "They (the Board) consider it of great importance that the teaching in rural schools should be associated closely with the environment of the children ; for various reasons it appears desirable at the present time to emphasise afresh the principle that the education given in rural schools should be intimately related to rural conditions of life. The Board do not suggest that rural elementary schools should teach agriculture or attempt to give a vocational training. Like other schools, they should give a general education based upon environment."¹

But the educational as opposed to the vocational aspect should never be ignored. To this end it seems advisable to shun such terms as "Agriculture," "Gardening," etc. Courses of instruction should not be too agricultural or too horticultural, but the teaching should include the principles underlying both as well as those underlying all natural processes. Although rural education should, to a large extent, be based upon local interests, it should not become parochial.

From the point of view of immediate environment and

¹ Board of Education, Education Pamphlet, No. 46, *Rural Education*, Appendix.

from that of the wider outlook, local conditions and the application of local knowledge being diverse, it is inadvisable to lay down any fixed scheme of work for all schools or for any one school in particular. It may, nevertheless, be advisable to suggest general lines of treatment along the paths of varied interest, otherwise rural education may become too narrow and circumscribed.

In any scheme of Rural Science, however, provision should be made for the practical study of environment through observation and experiment. This will involve the correct use of a piece of ground adjacent to the school and experiments in laboratory and workshop, where such are available.

The indoor work should be directly correlated with the outdoor. The underlying principles should be understood in application before they are considered in theory. It is not sufficient to carry out experiments either solely in a garden or in a laboratory. Both are necessary. Allied Manual Arts are also necessary, and should involve not only working in wood but in materials such as metal, cement (where necessary for practical purposes), raffia, etc.

Rural Science from this aspect will then be the science of everyday experience, the science which will awaken interest not only in rural environment—natural and social—but also in what underlies advancement in both natural and social life elsewhere.

The departure from the traditional primary school curriculum, in fact, implies a profound change in the scope and method of rural teaching; and to meet the situation it would appear to be necessary to envisage in a more definite manner the nature of the work which,

under the new conditions, will fall to the country teacher, and to make more specific provision for his training. There would appear to be two main possibilities in this direction: The first to provide this training within the period which the prospective teacher spends at the University and the Training Centre; the second to arrange suitable supplementary courses for teachers already on the staffs of rural schools.

In suggesting a course of training that will meet the requirements of the country teacher it should be emphasised at the outset that it must be as liberal as that of his town brother. Not only must it be of a character that will avoid the possible stigma attaching to a too narrowly specialised course, but it must be such as will not debar him from transfer to the town at a later stage, should circumstances make this desirable. What should be aimed at is a course of training specially suited to rural schools but constituting a sound qualification for general teaching in all kinds of schools.

Since in the average rural school highly specialised staffing will not be possible, the rural-science teacher must be competent to take his share in the general work of the school, and his training, therefore, must be framed on broad lines. General training will be provided as hitherto by courses in such subjects as English, History, Geography, Mathematics, and Science (Chemistry and Physics); specialised training should be provided for by the introduction into the curriculum of courses having a special bearing on the rural environment, such as Biology, Geology, Agriculture (Soils, Crops, and Manures), Agricultural Chemistry, Mensuration and Surveying, Rural History and Rural Economics. It should be pos-

sible also to find time for practical training in subjects such as Horticulture, Beekeeping, Handwork, Forestry, Navigation, etc.

With reference to the alternative training referred to, the provision of supplementary courses for teachers already in country schools, it is not forgotten that Training Centres already provide numerous vacation courses for teachers, which are widely taken advantage of. These courses are admirable so far as they go, but it is suggested that the time available does not make possible the fundamental training which is essential.

The new type of education can assume many forms, and we append schemes in several subjects as suggestions of what might be attempted in adapting teaching to local areas, together with suggestions in Mathematics and Science indicating aspects of these subjects specially appropriate to a Rural Course.

MATHEMATICS

First Year.—A beginning may be made with lineal measure.

Practical application will lead to the introduction of Symbolic Arithmetic.

Measurement may lead to consideration of the straight line-direction, positive and negative, positive and negative quantity with symbolic representation, collection of similar terms (Algebra).

Idea of direction suggests the principal points of the compass. Consideration of the vertical and the horizontal in connection with the plumb rule and the spirit level supplies links with handwork and garden. A link

with science may be established here by considering the lever and the balance, leading to simple equations.

After the straight line, the following may be taught: Angles at a point, right angle, use of instruments—set square, protractor, divider, compasses—testing the right angle (try square and T square)—drawing of angles, the setting out of a right angle on ground, *e.g.* a path at right angles to a given path—method of diagonal measurement—bisection of a line, an angle, drawing perpendiculars, drawing parallels, division of a straight line into any number of given equal parts, proportional division (Arithmetic).

At this stage the simple scale may be introduced.

The square—its construction, relation of sides and angles, subdivision of sides, construction of square measure table from lineal, arithmetical method of finding the area of a square, symbolic representation of the sides of a square, the idea of power, easy multiplication of like terms, square root, arithmetical problems involving the square in its application to rural environment, *e.g.* areas of plots, number of plants required for any given area, etc., with appropriate costings where applicable, construction of a rectangle, perimeter, area, multiplication by a binomial involving one variable, simple outdoor measurements drawn to scale, simple division, brackets, equations involving removal of brackets and easy fractions (Algebra).

The triangle—construction to given measurements (sides), practical exercises involving the triangle, congruency of triangles (demonstrated by imposition).

Graphical representation—plotting statistics, weather observations, etc.—averages, approximations, the keeping

of simple accounts, percentages, Profit and Loss, and problems in Simple Interest.

Second Year.—The Parallelogram—drawing, properties. Area of rectangle and parallelogram compared. Problems involving area, costings, percentages. Symbolic representation.

Area of triangle compared with that of parallelogram. Problems involving area of triangle. Further exercises in drawing to scale, plans, enlargement of figures, drawing to scale from actual measurements.

The right - angled triangle — Pythagoras' Theorem, practical and theoretical ; problems involved. Loci.

Simultaneous equations ; problems. Graphical representations. Factorisation. Standard Identities.

Measurement of land of irregular shape ; land surveyor's method ; base line, offsets, cross staff, field book, plotting, simple surveys.

For the commercial side of the work the following may be included : Proportional division, Commission and Insurance, Profit and Loss, Interest. This may entail simple Book-keeping.

Third Year.—The circle—circumference, radius, diameter—finding length of circumference—finding area of circle ; problems.

Chords, angles in a circle. Tangents. Inscribed and escribed circles. Factorisation, fractions, quadratic equations.

Problems ; graphical work ; simple logarithms.

Volumes of solids ; measurements of solids ; problems.

Land surveying. Use of prismatic compass, plane table.

Continuation of simple Book-keeping, Costings, etc.

Garden accounts—Profit and Loss.

SCIENCE

The following outline is presented so that what is generally designated "Experimental Science" may be correlated with the study of immediate environment and yet embody principles applicable to other general and scientific studies.

First Year.—In the initial stages some idea may be given of the Units and scientific terms,—Cm., Sq. Cm., C.C., Gm., Centigrade Degree ; the conversion of measures, *e.g.* metric and chain ; actual measurements in workshop, garden, field, and varied exercises on all important measures, all of which will be utilised in the Arithmetic lesson.

The teaching of the metric system is necessary for the understanding and use of apparatus. The cubic metric measure must be taught to understand the use of the Measuring Cylinder, Burette, and Pipette. Practical exercises can be given in the use of such apparatus, and correlation established with Arithmetic. Use can also be made of the metric measure in relation to rainfall—converting inches to C.C.—checked by actual measurement of rain-gauge water by means of a measuring cylinder. Exercises can also be given in the conversion of gallons to litres, etc.

The Gramme is necessary for weighing in the Balance. Practical exercises can be given in weighing such materials as soil, artificial manures, etc.

The use of the Balance requires some idea of the lever, and correlation can be established in the workshop—using tools—claw-hammer, shears, pliers, etc.; and in the garden—barrows, shears, secateurs, spade, fork, etc.

These preliminaries will lead to the actual study of science, and a beginning can be made with sedimentation, using river water, tap water, rain water, and sea water. This study of natural sedimentation—deposits of silt, sand, and other rock and vegetable materials—can be directed in two ways. Study can be made of the settling of sediment, the imposition of layers—the basis of rock formation (sedimentary)—and of filtration, its uses and employment in nature and by man.

Further study will lead to consideration of natural sediment, the study of rocks and some makers of sediment, *e.g.* the action of moving water, of wind, plants, and animals.

Before much more can be attempted, the principle of the Bunsen Burner must be taught. This will include not only the study of the ordinary laboratory Bunsen and the Lamb Laboratory Lamp—the substitute for the gas bunsen in rural districts, but also of the gas cooker, etc.

Having learned the principle and correct use of the Bunsen, the pupils can study evaporation of a filtered liquid, *e.g.* river water. From this will be learned that where filtration removes solid matter, evaporation removes dissolved matter, the residue on evaporation being merely noted. The study of natural waters will now proceed to condensation, and here rain may be studied, and also mist and dew. Use of the rain gauge may be further studied and daily readings recorded and graphed.

The condensation of water naturally leads to distillation, and the process of "clearing" natural water of sediment and soluble matter will be complete.

At this stage ideas of solution and of saturated solution can be given and crystallisation shown.

The study of water—hot and cold—will also include the expansion of water, illustrative of the simple thermometer. Expansion of mercury and of other liquids can be shown, and the principle and use of the mercury thermometer demonstrated.

This will involve the daily reading and charting of thermometer readings. Use may also be made of soil thermometers and of the Maximum and Minimum thermometer.

In dealing with the expansion of solids, account will be taken of effects of heat and cold upon rocks—heat and cold as weathering agents.

Study may now be directed to the natural effects of the various weathering agents, water, heat and cold, etc., on the two soil ingredients—sand and clay. Examination of soil under a hand lens may reveal the third and important ingredient, humus.

The study of the nature of sand and clay from the physical aspect may follow, and a simple analysis of a soil sample carried out mechanically. Subsoil may also be analysed mechanically and the results compared. This study will make use of the following: the balance, bunsen, decantation, and arithmetical processes.

Work may then be commenced on the structure of a seed—dicotyledons and monocotyledons; methods of germination; capillarity, and capillarity in the seed; simple diffusion and diffusion in the seed. The study

of air may follow, *e.g.* combustion, respiration, oxygen, nitrogen, carbon dioxide, oxides, when correlation may be established by studying air and the seed, respiration of seeds. A link may also be established with oxidation of rocks. Temperatures for germination of seeds may be studied, connected with air temperatures and soil temperatures, as shown by the thermometers. Correlation may then be made with Geography—the influence of temperature on the growing of certain crops in other lands.

Study may be made of the relation of germination to depth of sowing and the importance of good seed.

Second Year.—At the beginning of the term experiments involving the pressure of the atmosphere may be attempted, leading to the barometer as, first a measure of pressure, and second, as a means of forecasting weather. Barometer readings should be taken daily, graphed, and conclusions drawn.

Syphons, pumps, syringe, poultry drinking-trough.

Experiments may now be worked to show the behaviour of water : head of water—leading to water pressure; water supply; wells; springs; percolation of water through a soil; the soil's capacity for retaining water; the water table; capillarity in a soil; the value of soil cultivation, water-logged soils, and drainage.

Further study of water will be concerned with chemical change—water as a compound. Natural waters will be studied and the influence of rock matter on water—hardness, temporary and permanent hardness of water with methods of softening. Acids and alkalis.

Experiments in the transmission of heat : conduction

of heat in soil, convection—ventilation—convection with respect to soils—radiation of heat from soils, principles involved in the greenhouse ; influence of light and dull surfaces on absorption and radiation of heat, connected with light coloured and dark soils.

Plant study may deal with the independence of the young plant—roots, uses, kinds, behaviour, effect of gravity, root cap and hairs, how roots absorb moisture, osmosis, the stem and its work, development of branches, the opening of leaves, stems with special functions, stem as conductor, the structure of the leaf, leaf arrangement, how plants get rid of excess moisture, the water cycle—rain, soil, root absorption, stem, leaf, transpiration—respiration of plants—comparison in seed and animals—parts of the simple flower, simple fruits.

Experiments may be given on upthrust of water, buoyancy—cistern ball, ships, fishing nets, the heaviness of a bucket of water when taken out of a well, the hydrometer, lactometer, uses, the Principle of Archimedes, specific gravity of solids—common substances, *e.g.* milk, and various solutions.

Third Year.—Experiments may be performed in Heat Capacity of liquids and solids—comparison of heat capacities of such substances as water and paraffin, water and mercury, lead shot and sand, sand and clay.

The Calorie: Specific heat of water, of solids, such as metals, sand, clay.

Cold and Late soils, in relation to specific heat of constituents. Latent Heat—connection with temperature in the atmosphere, climate, etc.

Further study of acids and alkalis ; neutralisation ;

nature of salts. Simple qualitative analysis of the soil—tests for nitrogen (nitrates), phosphorus (phosphates), sulphur (sulphates), potash. Substances in the combustible part of the plant—testing for water (oxygen and hydrogen), nitrogen, carbon; nitrates, sulphates, phosphates, iron.

Testing for organic compounds in plants—starch, oil. How plants obtain their food.

The testing of manures—farm-yard, chemical, seaweed. Effects of lime on soil and plant.

Rotations of crops.

HORTICULTURE

Horticulture Correlated with Rural Science and Mathematics.—In many cases Rural Science has, in the past, been taught more as a self-contained subject than in conjunction with cultural operations to demonstrate the principles underlying practical work. Practical work out-of-doors which omits the scientific explanations involved, whilst infinitely better and more useful for the rural population in after-life than the opposite method, likewise fails to attain the ideal, which demands that the connections between practice and science should be adequately established and clearly demonstrated.

Horticulture Crops v. Agriculture Crops as a Foundation for the Teaching of Rural Science.—Whilst agriculture is the main rural occupation, there are areas, especially in small-holding localities, where commercial horticulture is very important and is extending. Both in rural and industrial areas horticulture still enlists the interest of many members of other arts and crafts ; this assertion

is supported by the demand for, and attendances at, public lecture-courses. The principles underlying such aspects as soil treatment, manuring, germination, and other biological phenomena are essentially the same for agriculture as for horticulture. To discard the old school garden or horticultural crops and substitute agricultural crops would be to restrict the scope and interest of teacher and scholar alike. It would curtail the physiological, intellectual, æsthetic, recreational, and practical aspects of the whole scheme not only during the school life but afterwards.

Horticulture, during the period 1914 to 1919, augmented the home-food supply ; how large a part the old school-garden played in the teaching of this crop production will never be known. To-day horticulture plays its part in the environment and social aspects of our cities, particularly as a result of slum-clearance schemes. Many are brought into contact with nature and her teachings through the medium of work in their own gardens, more so than through the casual observations of agricultural pursuits.

A representative proportion of horticultural and agricultural crops, including arboriculture and apiculture, approaches the ideal. Arboriculture and apiculture are to be preferred, and present increased opportunities of the study and the demonstration of principles when associated with horticultural crops, including fruit and flowers.

In the past, unpractical methods were frequently devised to establish representative agricultural grain and grass plots within the restricted limits of a school garden, wrong impressions and false values being thus

created. Visits to farms would, no doubt, offer greater facilities for studying many agricultural practices than the school garden.

Vegetable and fruit crops grown in the school garden afford the means of practical instruction in cultivation, serve as a basis for rural science principles, supply material for cookery classes, and even lead to economy in the provision of school meals. The floral specimens of the garden may, with advantage, provide material for drawing and painting lessons and specimens for nature study, besides catering for the teaching of æsthetic principles.

Most agricultural crops do not lend themselves readily to such purposes, nor do they give such a wide variation in types of vegetation.

SILVICULTURE

Silviculture or the growing of woods, as opposed to arboriculture or the growing of individual trees, has, since the establishment of the Forestry Commission, assumed a definite place in Scottish rural economy. The increasing activities of the Commission ensure that this branch of rural industry will grow in importance. For example, 275,000 acres have already been acquired in Scotland by the State and 50,000 acres have been afforested. State nurseries for the propagation of plants number over 40 and extend to 275 acres. The Commission has created 200 forest-workers' holdings, and the formation of these will continue, while every year from 9000 to 12,000 acres or more will be added to the plantations.

Although arboriculture may justifiably be regarded

merely as a branch or an extension of horticulture, the industry of silviculture differs fundamentally both from horticulture and from agriculture, and ought, therefore, to have a place in the curriculum of rural schools, commensurate with its importance. The greater the part played by silviculture as a local industry the larger should be its place in the school curriculum of the district.

There are certain parishes in Scotland where silviculture and forestry are, or in future will be, the basic industries of the community. Such parishes will be found in the counties of Moray, Nairn, Perth, Argyll, Aberdeen, Ross, Inverness, and, to a less extent, elsewhere. In such districts the teaching of all elementary science subjects should be illustrated by practical examples which have a direct bearing upon silviculture. For example, in speaking of soils the nature of the forest soil might be demonstrated; in teaching botany, the local trees would form the main subject of study; in teaching zoology, animals, insects, and birds harmful and useful to the forest would be dealt with; in mechanics, the numerous and diverse forest tools might be the subject of study and demonstration; and so on.

In such districts while it is suggested that this silvicultural bent might be given to all science subjects taught at all ages, something more would be necessary during the final school year. One or two hours a week might be allotted in that year to teaching silviculture as a special subject, as is done with apiculture, poultry-keeping, etc. The history and objects of the industry might be taught: its relationship to other industries, its importance in modern civilisation, the geography of silvicult-

ture, etc. The pupils would be advised regarding future training for and prospects in silviculture as a career.

In other parishes and counties, where silviculture is not, and is never likely to be, an important local industry, less emphasis would be laid upon silvicultural objects in teaching the basic science subjects, but these objects should never be entirely omitted. It might, however, in such places be sufficient to deal with silviculture in its purely arboricultural aspects, possibly along with horticulture, occasional use being made of trees for demonstrational purposes. A special course would not be required, but pupils would be taught to recognise the commoner trees, and, in the Handwork class, the properties and uses of the commoner timbers.

The provision of facilities for imparting some knowledge of silviculture in accordance with the above suggestions will vary according to the local requirements. Where no special instruction is necessary, silvicultural knowledge would be imparted by resident teachers, in the teaching of such subjects as Botany, Horticulture, Handwork, etc. As a rule, there will be sufficient material available in any district for simple demonstration purposes.

In districts where special instruction is advocated, this might be carried out, as in the case of apiculture, poultry-keeping, etc., through the medium of itinerant teachers specially trained in silviculture. If this could not always be justified, the services of a competent person, locally employed in silviculture, might be secured. In such districts facilities for practical work, demonstration, and the supply of material would be

essential. In most of the forestry counties it should be possible for the Education Committees to arrange for such facilities from the Forestry Commission, or, through the good offices of the Royal Scottish Arboricultural Society, from local landowners. In some districts the County Councils might even acquire small areas of waste land near schools, to be used partly as a forest nursery and partly for planting work and the growing of class material. These nurseries might even be used for the production of trees to be planted as roadside trees, in counties where the County Councils choose to exercise their powers in that connection. If County Councils should in future come to administer odd small areas of woodland in their districts with the intention of preserving the amenity of such districts, blocks of a few acres in extent might easily be set aside for educational purposes. In this way pupils would be able to study silviculture during the plantation and final stages, in which it differs so greatly from other industries, such as agriculture and horticulture. In such reserved areas the essential principles of silviculture could be taught in a way which is quite impossible in the school garden or nursery.

FORESTRY

First Year.—Forest Physiography.

Soil :

(a) Origin of Soil ; (b) Formation of Indigenous Soil.

Composition of Soil :

(a) Mineral Constituents of Soil ; (b) Organic Matter or Humus ; (c) Water ; (d) Gases.

Classification of Soils.

Climate :

- (a) Heat ; (b) Light ; (c) Moisture ; (d) Air Currents.

Tree Species :

- (a) Distribution ; (b) Classification.

Second Year.

Forest Botany :

- (a) Identification of Species, *i.e.* Conifers—Broad Leaved ; (b) Natural Factors influencing growth of different species and their distribution.

The Root Structure and Functions:

- (a) Function and types of leaves ; (b) Rise and Descent of the Sap.

Silviculture :

- (a) Choice of Species ; (b) Choice of Methods of Afforestation, *i.e.* Sowing, Planting, Regeneration.

Third Year.

Seeding: Testing of Seed.

Forest Nursery—Permanent—Temporary.

Choice of Nursery :

- (a) Soil ; (b) Exposure.

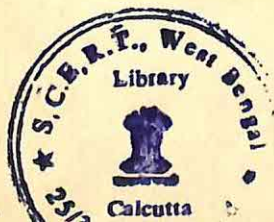
Laying out of Beds:

- (a) Sowing ; (b) Management of Seedlings ; (c) Transplanting, Planting out, Lifting, Packing, Conveying ; (d) Methods of Planting ; (e) Distance apart, Spacing.

Forest Protection :

- (a) Some Fungoid Diseases ; (b) some Insect Pests.

Measurement of Timber.



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HANDWORK¹

HANDWORK IN RELATION TO RURAL SUBJECTS

Handwork should form part of the normal instruction of a Rural Advanced Division School. Apart from the manipulative skill that the pupils acquire in the use of tools, instruction should be given in the elementary mechanics of tools. The mechanical principles underlying the construction of models made is knowledge of a scientific character.

Handwork instruction should include the kinds, properties, and qualities of woods, seasoning, wood preservatives, the structure of wood, and products formed by chemical changes and decomposition. Similar instruction should be given regarding iron, steel, copper, brass, etc.

Handwork in rural schools should be directly related to the environment. A progressive course should stimulate the interest of the pupils by projects suggestive of rural life and economy. The actual objects made should bear a relation to the garden, the laboratory, and to home life.

Handwork instruction thus regarded should include working in wood and metal, in raffia, straw, rope, and in cement.

There are many objects of interest and use which can be made in wood. Small fittings, pieces of apparatus and tools, such as retort stands, tongs, scoops, trowels, line pins, can easily be constructed in metal. Few tools are required for the purpose.

Rough sketches should be made from specimen objects, and a correct drawing made to scale therefrom.

¹ See also under Technical Courses.

MANIPULATION OF ROPE FOR FARM PURPOSES

The manipulation of rope and cordage is a subject of practical mechanics.

Rope in one form or other is used almost daily by everyone in rural areas, but few can handle it methodically. It is indispensable about a farm, and the security of both life and property may depend on the use of rope of the proper material and construction and the rapidity and accuracy of making the knot or fastening best suited to the occasion.

A knowledge of the various plants grown for rope-making material, of their cultivation, soil and climatic requirements, the transport of the raw material to the factory, the various processes of manufacture, bring the subject into relationship with the study of Rural Science, Geography, Chemistry, and Practical Mechanics.

The making of the various knots and appliances required for farm purposes calls for thoughtful study as well as manipulative skill, and from this point of view alone the subject provides a suitable training in Handwork for Advanced Division pupils. From a utilitarian point of view its claim as a subject of school instruction in a Rural Course is indisputable.

The following examples may be cited to show the scope of the instruction and its usefulness as a training for after-school occupation in agriculture and rural industry generally:—

Uniting Ropes.

- (1) *Knots*.—Overhand, Flemish, Reef or Square, Sheet Bend, Weaver, Fisherman's, Carrick Bend.
- (2) *Splices*.—Short Splice, Long Splice.

Eye Knots or Loops.

- (1) *At End of Rope.*—Bowline, Crabber, Fisherman's Eye, Overhand Eye, Flemish Eye, Ploughman's Eye, Eye Splice.
- (2) *In Centre of Rope.*—Double Bowline, Saddler's Loop, Farmer's Loop, Dalliance Knot, Artillery Knot.

Finishing Rope Ends.—Whipping (various), Crown and Back Splice, Wall Knot.

Fastening Ropes by Hitches and Bends.

- (1) *To Spars.*—Clove Hitch, Scaffold Hitch, Timber Hitch, Killick Hitch, Fisherman's Bend.
- (2) *To Rings.*—Jerk's Head, Ploughman's, Bucket, Capstan.
- (3) *To Hooks and Tackle.*—Lumber, Catspaw, Spanish, and Blackwall Hitches.

Shortening Ropes by Knots and Hitches.—Sheepshanks (various), Chain Knots (various), Overhand Loop Knot, Chain Knot, Twist Knot.

Application of Knowledge of Knots, Hitches, Bends, Splicing, Whipping, etc., to Farm Uses.

For Halters.—Temporary, Universal, Guard Loop, Standard, Neck Halters, Halter Ties.

For Harness.—Reins for plough and cart, Check ropes, Drought and Tracing ropes. Rope Bridles.

For Cart.—Fastening of Girdings, Hay-knot, Belly-bands.

Stack roping and weighing. Slings for sacks, barrels, cans, bales of hay, etc. Erecting and repairing sheep-nets.

Roping of animals for veterinary purposes. Roping of purchase Tackle. Rope ladders. Erection of scaffolding. Lashing of spars. Whipping handles, etc. etc.

DAIRYING

The course of instruction in Elementary Dairy Science herein outlined is intended as one of a group of Rural Science subjects, including Poultry Science and Cookery, for the first and second years of the Advanced Division of Rural Schools.

The course comprises a series of elementary lessons in Dairy Science, and is designed as a preparation for a more advanced course in the science and practice of dairying to be given in the third year of the Advanced Division and at Continuation Classes. The instruction may be undertaken in the meantime by the instructresses of the Agricultural College in a limited number of approved schools.

The subject should be taught as far as possible by means of simple experiments and practical demonstrations, and the fullest use be made of samples of milk, milk products, utensils and dairy materials generally, as teaching specimens. The lessons should also be illustrated by the aid of diagrams, charts, blackboard sketches, models, etc. The instruction should be correlated with other school subjects, such as Cookery, Arithmetic, English, Geography, etc. The pupils should make notes of the lessons in notebooks specially kept for the purpose. The classroom instruction should be supplemented by visits to farms in the vicinity of the school, where facilities are available for demonstrations in dairy work.

The following is an outline of the items to be included in the course, their sequence of study, and method of treatment :—

Properties and Composition of Milk.—Examine samples of fresh cow's milk—ascertain colour, taste, smell, weight. Demonstrate power of fresh milk to absorb taints from neighbouring substances. Effect of acid on milk—curdling.

Demonstrate by simple experiments the principal constituents of cow's milk, *i.e.* fat, casein, albumen, sugar, minerals, water. Examine and compare each of the constituents with similar substances from other sources.

Illustrate the percentage composition of average cow's milk by means of diagrams and other devices, and compare with the composition of other milks—goat, sheep, mare, etc.

Demonstrate milk as an emulsion—distinguish from a solution.

Dairy Cow and Milk Yield.—Study Nature's purpose of milk and man's purpose. Explain methods used to increase milk yield of dairy cows. Explain lactation period, and give average milk yield of a dairy cow. Show pictures of a typical dairy cow and of the principal British dairy breeds.

Dairy arithmetic—calculations of total annual milk yield of average cow—the weights of butter and cheese from a given volume of average milk, etc. etc.

Milk as a Food.—Milk as Nature's perfect food for infants and young animals—indicated by rapid growth of these when fed solely on their mother's milk—illustrate by statistics. Show diagrams comparing composition of milk with that of the animal body, also with eggs, meat, oatmeal, white bread, etc. Milk constituents wholly

digestible, and hence its superiority as a food. Refer to results of experiments with city school-children from a daily ration of milk. The national importance of milk as a food—the food value of skim milk. Compare the annual consumption of milk per head of population in Britain with that in other countries—national importance of increased consumption of milk.

Effect of rennet on milk—formation of hard milk-clot in stomach, and the means to prevent this. How to use milk as food for invalids.

Demonstrate the use of milk for cooking purposes—rate of boiling—the effect of heating and boiling milk on its food constituents—“singeing” and its cause—change of taste and colour.

Examine samples of various kinds of dried and condensed milks, and commercial milk products sold for food—note principal differences of their food value with that of fresh whole milk.

The study of this part of the subject should be correlated with Cookery and Geography.

Bacteria in relation to Milk.—Simple study of bacteria—their nature and minute size, condition of life and product of growth. Why milk is a perfect food for bacteria. Demonstrate “souring” as due to bacteria. Useful and harmful bacteria—the importance of useful bacteria in dairy work; danger of harmful bacteria in milk, butter, cheese. The control of bacteria in milk by heat and cold. Atmospheric temperatures in relation to the keeping of milk.

Demonstrate use of the thermometer in regulating temperatures. Demonstrate “pasteurisation” and dis-

tinguish from boiling of milk. Sources of bacterial infection of milk—dirty cows, dirty utensils, dirty workers, dirty water, dust, flies, etc.

Clean Milk—its Production and Care.—Examine samples of “clean” milk and ordinary farm milk. Filter each through cotton-wool and note the result. Place filtered samples of each in large test tubes with cotton-wool stoppers, set aside for a few days, examine and demonstrate the result, *i.e.* filter removes “visible” dirt, but not “invisible” dirt or bacteria. Define “clean” milk in terms of bacterial content and absence of harmful bacteria.

Simple study of milk secretion—illustrate by black-board sketches and diagram of cow’s udder. Compare keeping qualities of samples of first-drawn milk and milk drawn later—necessity for rejecting first-drawn milk.

Study “Golden Rules” to be observed in the production of “clean” milk, and the principles underlying these. Demonstrate the cleaning of dairy utensils, milk vessels, bottles, jugs, etc. Distinguish between “scalding” and “sterilising,” and discuss principles underlying the various operations. Study the care of milk in the home, and demonstrate simple devices for keeping “clean” milk free from contamination and in sweet condition.

To give pupils an intelligent grasp of this section of the subject, practical demonstrations on the production and handling of “clean” milk should be given by the instructress at a farm in the vicinity of the school, where the necessary facilities are available. Pupils should be

encouraged to practise milking and clean milk methods at home, where there are facilities for such, and to bring samples of the milk to school for examination.

Milk Products:

1. *Cream*—average composition. Demonstrate separation by gravitation and by centrifugal methods, *i.e.* the separator. Demonstrate ripening of cream.

2. *Butter*—average composition. Give practical demonstrations in the making of butter, and study the principles underlying the various processes.

3. *Cheese*—composition of Cheddar cheese. Rennet—its source and action on milk. Give practical demonstrations in the making of whole-milk cheese, and study the principles underlying the various processes.

POULTRY SCIENCE

With a view to demonstrating the suitability of Poultry Science as a subject of instruction for post-primary pupils in rural schools, the North of Scotland College of Agriculture, with the co-operation of several County Education Authorities, commenced an experiment in the teaching of this subject in 1926 at a number of selected rural schools. In the absence of day-school teachers with qualifications in the subject, the instruction has been undertaken by the Poultry Instructresses of the College.

The experiment, which is still proceeding, has clearly shown that Poultry Science lends itself admirably to the teaching of post-primary pupils in rural schools, both on educational grounds and as a preparation for their after-school education and vocations.

In the experiment the instruction had perforce to be concluded in one complete school year, the first- and second-year pupils of the Advanced Division being combined for this purpose. The subject could, however, be spread over a longer period, if so desired. A minimum of three hours' instruction per week is required to accomplish the work in a school year.

The course was originally intended for girls, to be taken along with Dairy Science and Cookery, to form a group of subjects to be termed Rural and Domestic Science. The subject is equally suitable for boys, however, and could be similarly grouped with other Rural Science subjects in keeping with their after-school requirements.

There is an abundance of material available for the teaching of Poultry Science. Live fowls are easily obtainable from the children's homes or from farms in the vicinity, as are also the necessary anatomical specimens. Poultry-houses and appliances can be examined at neighbouring farms or in the school poultry-run ; and the principles involved in their structure and use can also be taught from models and diagrams. Most of the apparatus required for simple bench experiments and demonstrations can be made by the pupils, and the necessary chemical apparatus and reagents can be obtained at small cost.

A school poultry-pen would be required to provide live fowls of different breeds and types, appliances and other poultry material as teaching specimens, where these are not otherwise available.

The aim of Poultry Science is to give the pupils a greater interest in their school work by

associating it with poultry-keeping—one of the most important subjects of economic interest in rural districts—and with the care of living creatures at their homes, and to instruct the pupils in the elementary principles of the more important operations of poultry-keeping.

Poultry are of everyday concern to most farm and village children, and no difficulty is experienced in arousing the liveliest participation in the lessons by even the dullest pupils in the class. The parents are also keenly interested in the subject, a fact which acts as an incentive both to teacher and pupils, and adds to the value of Poultry Science as a subject of school instruction.

The subject is taught in a series of lessons based on the examination and study of living fowls, anatomical specimens of the fowl and the larger wild birds, poultry-houses and appliances, poultry foods and products, models, diagrams, etc., and on the information got from the pupils as a result of their own observations on and experience with poultry at their homes. The instruction is supplemented, where necessary, by simple experiments and demonstrations, by visits to poultry-runs, etc. The pupils are taught to examine, describe, and study the specimens provided for the lessons, and to reason and find out the why and wherefore of the more important operations in the management of the domestic fowl.

The instruction is not intended as a training in Poultry-keeping any more than the teaching of Plant Husbandry in Rural Science is meant as a training in arable farming. It is a study of the elementary principles on which the successful domestication of the hen for commercial

purposes is based. The instruction is educational and not occupational. The pupils are trained to systematic methods of observation on, and description of, matters connected therewith, and to reason out and record their conclusions. But the knowledge thus acquired is closely associated with the methods of practice of the poultry-yard and with poultry business generally, and its usefulness for after-school purposes is impressed on the pupils. The utility aspect of the instruction is further emphasised by encouraging the children to observe and study the methods of poultry management at their homes in the light of their school instruction. Parents usually co-operate in this kind of "home-work," and readily give their children facilities to practise some of the more interesting operations of poultry-keeping. A discussion and study in the class of this kind of "home-work," and of the principles involved, add greatly to the interest and efficacy of the instruction.

Poultry Science gives many opportunities for correlation with other branches of school instruction. The study of the subject is largely a matter of accurate observation and correct description, and so provides useful exercises in English composition. It also introduces new words and phraseology and encourages wider reading.

The origin of the various breeds of poultry, the world's Egg Trade and Markets, and the industrial and commercial phases of the world's Poultry Industry generally provide interesting lessons in Geography. The subject also provides useful exercises in measurement, drawing to scale, weighing, calculations of weights, prices, percentages, etc. etc. The study of the natural history

of the domestic fowl—its external features, structure, digestive system, comparison with its jungle ancestor and wild birds of the district, incubation, common parasites, etc., brings the subject into relationship with the study of Zoology. Its relation to Cookery is self-evident, and needs no comment. The making of model poultry-houses and appliances, and the utilisation of feathers in the making of hat and dress ornaments, fishing-flies, dusters, quill-pens, etc., are examples of Handwork related to Poultry Science.

Teacher's Qualification.—To teach the subject successfully on the lines indicated above, a trained teacher with qualifications in Zoology and a special course in Poultry-keeping is necessary. Probably a six months' training in Poultry Management at one of the Agricultural College Poultry Farms would be sufficient for this purpose.

The employment of itinerant teachers with special qualifications in Poultry and Dairy Science would appear to be the most practical and economical way of extending the instruction of these subjects to post-primary pupils in rural schools.

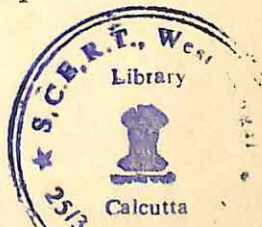
BEEKEEPING

First Year:

Natural History.—Recognition of worker bee, drones, and queen, such elementary anatomy as the divisions of the body, the legs, wings, eyes, and sting. The food of bees—honey and pollen.

Apparatus.—The hive, frames, bee-space, quilts, smoker and subduing-cloth, veil and gloves.

Handling Bees.—Use of smoker or cloth. Importance of gentleness and slow movement.



Things seen in the Hive.—Honey-comb, Brood-comb (worker, drone, and queen). "Brood," stores (honey and pollen), caste examples.

Honey Production.—Bees working in "supers," finished honey, extraction of honey.

Second Year:

Natural History.—Development of bee from egg to perfect insect. Eyes (simple and compound), "tongue," mandibles, wing-hooks, feet, pollen-baskets, pollen-combs.

Floral parts, connection of flowers with bees, fertilisation (fruit and clover blossom). Collection of nectar, water, pollen, and propolis.

Apparatus.—Details of hive construction, sizes, bee-spaces, exclusion of dampness, ventilation, porch and alighting-board.

Handling Bees.—Influence of race, situation, and season on the temper of bees. Preparation of smoker and subduing-cloth. Practice in handling bees.

Things seen in the Hive.—Laying of the queen, growth of larvæ, bees laden with pollen and nectar, deposition and packing of pollen, young bees emerging from cells, detection of worker, drone and queen larvæ, sealing of cells (honey and brood).

Study of the Colony.—Each bee is a fraction like the leaf of a tree, the colony is the unit, and swarming is reproduction.

Phenomena of swarming, scout bees, queen-cells, meaning of "primary cluster," hiving the swarm.

Honey Production.—Preparation of "supers" for comb and extracted honey. Adding first and subsequent supers. Queen-excluder. The handling of swarms. Removal of supers, extraction of honey, and preparation of honey for marketing.

Preparation of stocks for wintering.

Third Year:

Natural History.—Classification of bee, study of related types (humble bee, solitary bee, wasp), respiration of bee, secretion of wax. Revisal of anatomy with study of body parts by means of lens or microscope.

Pollen and its function. Bees are essential for the survival of leguminous plants and of many kinds of fruit. Relation of bees to pasture and their agency in restoring nitrogen to soil. How bees are attracted to flowers (development of colour and scent).

Prevention of self-fertilisation (diœcious plants, pin- and thrum-eyed primroses).

Organ of Nassanoff (scent-organ of the bee) and its use at swarming time—to the bee and the bee-keeper.

Apparatus.—Application of physics to hive construction, effect of capillarity on roof and joints of hive. Loss of heat by conduction, convection currents, and by evaporation of moisture.

Feeders and feeding. Air-pressure in jar-feeder.

Honey Production.—"Nurse" and "surplus" bees. Swarming is disastrous, control of swarming. Size of hive and race of bee. The super-clearer. Honey-extraction and use of strainer. Honey containers.

Queen-Rearing.—Simulating queen-cell production, making nucleus stocks for the mating of queens. "Introduction" of queens. Utility of drones. Making new stocks of bees.

Bee Disease.—Symptoms and treatment of Foul Brood (American and European), of Addled Brood, Sacbrood, Dysentery, and Isle of Wight or Acarine Disease.

Moving Bees.—"Homing" in the bee, with its limits. Packing bees for transit. Sending queens and bee-samples by post. Trading in bees.

NAVIGATION

All officers of the Mercantile Marine, Steam Trawlers, and Herring Drifters must possess B.O.T. Certificates, and the standards of examination for these have been steadily rising for a number of years past. The conditions of service at sea are such that these prospective candidates have little or no time for private study, and when they have the necessary years of service and wish to qualify for any certificate they have usually to give up their berths, come ashore, and hurry through a few weeks of a concentrated course, which is more or less sheer cram work. The percentage of failures, especially among those who have had no previous instruction in the day school or cadet courses, is very high, so much so, that a prominent shipowner recently denounced the (in his opinion) needlessly high standard demanded by the B.O.T., as it was leading to a grave shortage of qualified officers in the Merchant Service. In the fishing-fleets at the more progressive centres there is no such shortage but rather a surplus, and it is not unusual to find several qualified skippers and second hands in a single crew, even acting as drivers or stokers in the engine-room. For many of these young men the future holds little or no prospect of their ever possessing a boat of their own or of acting skipper in another's boat; and yet year after year, despite the adverse conditions of the fishing industry, they come forward in considerable numbers to attend the classes in Navigation and First Aid conducted by the Education Committees. The low fees charged make it possible for almost anyone to qualify even in these times of stress and strain.

It is true that the short session and the high standard of efficiency demanded make the work of preparation for B.O.T. examinations difficult and strenuous for teachers and students alike, but this is just where a well-graded course in the Day School is of inestimable value when the subject has been taught from first principles and by experiments and not by "Rule of Thumb," as it unfortunately too often is. Some textbooks are full of these Rules, which may at times serve a useful purpose if accompanied by suitable explanations as to the reasons why, but their use in school should not be encouraged.

Navigation is a mathematical subject and can be taught as such with additions from the various branches of Physics, the limits of the application of first principles and experiment being reached only when difficult formulæ requiring the use of spherical trigonometry are involved, as in the determination of longitude from an altitude of the sun. The subject should be introduced by a little Geography, the shape and size of the earth, latitude and longitude and their respective values in miles and time, also the determination of positions by latitude and longitude. Experiments with magnets and soft-iron bars lead the student to an appreciation of the use of the Mariner's Compass as a guiding instrument and of the deviation to which it is liable through magnetic influences in the earth and the ship. Rulers, compasses, and protractors should be freely used in the construction of figures, illustrating the correction of courses or bearings for variation and deviation. In time this can be dispensed with, as pupils soon acquire aptitude in solving these problems mentally or by rough sketches. Chart

work makes a strong appeal, and the laying down of courses and bearings accurately requires some manipulative skill with compasses, dividers, parallel rulers, etc. Current sailing is an application of the parallelogram of forces or velocities, and presents little difficulty when treated as such. The actual construction of charts and the sailings, plane, traverse, etc., are beyond the scope of the present B.O.T. requirements for fishermen, but might be introduced, in part at least, after the pupils have a knowledge of trigonometrical ratios and the use of logarithmic tables. This knowledge also leads to an understanding of Traverse Tables which are used to solve problems on the day's work, but these problems should also be worked out practically by laying down the various corrected courses on a chart. Exercises on Reduction to Soundings can also be solved by geometrical construction and checked by Traverse Tables.

Simple experiments with mirrors to illustrate the laws of reflection, and the method of reading a vernier scale, lead to the construction and use of the Sextant. The refraction of light can be easily demonstrated by glass prisms or a trough of water, while a lesson on the seasons will explain the sun's declination—an important factor in the solution of problems in Nautical Astronomy.

Opinion differs as to how far the thirty-one Articles of the "Rule of the Road" should be studied in the day school, but the fact that B.O.T. examiners usually insist on a verbatim repetition of certain articles suggests that these might with advantage be taught in school. The Steering and Sailing Rules, especially Article 17, afford excellent exercise, and present considerable difficulties to many B.O.T. candidates when illustrated

with model lights on a table, although these men have been applying them regularly at sea for years.

Concurrent with the purely nautical work there should be a course of sea crafts, including signalling, the knotting and splicing of ropes, and, where feasible, the mending of nets and basket work.

Practically every fisher lad starts his seafaring career as cook, and the institution of cookery classes in certain schools has been a great boon to the lads, and through them to the crews. Woodwork is a favourite subject with fisher lads both in day and evening schools, and is well worth the time devoted to it.

The science which would form part of a Nautical Course should be as wide as possible, somewhat on the lines of the Scottish Education Department's three years' course, and including Marine Biology; but this widening of the science could only be brought about by increasing the demonstration and reducing the individual practical work—a change from the usual custom which would not be serious in a course embracing otherwise so much work of a practical nature.

Along the lines indicated above much excellent work has been done in some day schools and continued in the evening classes. The B.O.T. are fully aware of and appreciate the great advance made in recent years in the teaching of Navigation on educational lines.

The question arises as to what benefit a student would derive from the possession of a certificate testifying to the completion of a three years' course of Navigation and allied subjects, apart from the additional knowledge and training acquired? At present the answer seems to be—no benefit. Certificates granted by certain Nautical

Schools on the completion of a somewhat similar course are recognised by the Shipping Companies and count as equivalent to six months, or thereby, of apprenticeship at sea. This is an important concession, and if certificates granted by the Department were similarly recognised it would greatly benefit students whose parents are financially unable to send their boys to these special schools.

As four or five years would elapse between the gaining of a School Certificate and the earliest age at which a student could sit a B.O.T. examination (19 years) it is almost certain that the B.O.T. would not recognise the certificate as exempting a candidate from any part of their examination. They would be more likely to raise the standard of the fishermen's examination still nearer to the level for foreign service certificates. This might be a distinct hardship in many cases, but it would tend to facilitate transference from the fishing-fleet to the higher and wider service of the Mercantile Marine.



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